

## **REMARKS**

Claims 10-15 and 20 are amended; new claim 87 is added; claims 1-9, 16-19, 21-27, 29, 30, 32 and 34-86 are cancelled; and claims 12-15, 20, 28 and 87 are pending in the application. Claims 10, 11, 31 and 33 are withdrawn from consideration as pertaining to a non-elected species, but remain pending in the application in the event that claims 20 and 87, from such claims depend, are found allowable.

The pending claims stand rejected over Lee I (US 2004/0238872), either alone or in combination with Lee II (US 7,151,039) and Yamamoto (US 6,936,901).

The undersigned conducted an interview with Examiner Robert Vetere on July 17, 2008. During such interview, claims 1 and 14 were discussed. Specifically, the undersigned discussed amending claim 14 so that the recited pulse sequence would be TMA-(TMEA-H-O<sub>3</sub>)<sub>x</sub>, where x is an integer greater than or equal to two; and it was proposed that claim 1 would be amended to clarify that the recited process would improve conformity of a deposit of hafnium-containing material relative to that which would occur in the absence of utilizing TMA during formation of the hafnium-containing material.

No agreement was reached as to whether such amendments would place the claims in condition for allowance. However, the Examiner indicated that the amendment to claim 14 seemed like a reasonable distinction over the cited references, and specifically relative to Lee I (US 2004/0238872). The Examiner wanted additional time to consider if the amendment to claim 1 would actually distinguish relative to Lee I, or instead would merely recite subject matter that is inherent in Lee I.

The undersigned thanks the Examiner for the numerous helpful comments and suggestions provided during the interview of July 17, 2008. Applicant has amended claim 14 to incorporate the subject matter discussed during the interview. Applicant has also canceled claim 1, and replaced it with a new claim 87 that recites the subject matter discussed during the interview in combination with the subject matter of previous claim 1.

During the interview of July 17, 2008, it was also discussed that the present invention pertains to pulsing of two metal-containing precursors into reaction chamber prior to pulsing of reactant. This distinguishes the present invention over the cited references of Lee II (US 7,151,039) and Yamamoto (US 6,936,901). Accordingly, the discussion herein will focus primarily on distinguishing the presently pending claims relative to Lee I (US 2004/0238872), as Lee I is the only cited reference which describes utilization of two metal-containing precursor pulses followed by a reactant pulse.

Claim amendments provided herein amend claims 14 and 15 to place the claims in independent form, and to indicate that recited pulse sequences are either TMA-(TMEAHO<sub>3</sub>)<sub>x</sub>, where x is an integer greater than or equal to two (claim 14); or TMA-(TDMAH-O<sub>3</sub>)<sub>x</sub>, where x is an integer greater than or equal to two (claim 15). The utilization of multiple TMEAHO<sub>3</sub> cycles advantageously increases the amount of hafnium in a layer relative to the amount of aluminum, while maintaining improvement in self-limitation relative to utilization of the hafnium-containing precursor (either TMEAHO<sub>3</sub> or TDMAH-O<sub>3</sub>) alone, as discussed in paragraph 0039 of the specification. Thus, the utilization of multiple TMEAHO<sub>3</sub> cycles (claim 14), or TDMAH-O<sub>3</sub> cycles (claim 15) provides distinct advantages not recognized by Lee I, or the other cited references.

Claims 14 and 15 are believed allowable for the reasons discussed above, and applicant therefore respectfully requests formal allowance of claims 14 and 15 in the Examiner's next action.

New claim 87 recites a process in which an ALD-type pulse sequence of  $M_1$ - $M_2$ -R is utilized, where one of  $M_1$  and  $M_2$  is a hafnium-containing precursor (specifically, one or both of TMEAH and TDMAH), and the other of  $M_1$  and  $M_2$  is an aluminum-containing precursor (specifically, TMA). Claim 87 further recites that the utilization of the TMA improves conformality of a hafnium-containing material formed with the pulse sequence  $M_1$ - $M_2$ -R relative to the conformality that would occur with an ALD-type process utilizing one or both of TMEAH and TDMAH in the absence of TMA. The claim 87 recited improvement in conformality is supported by the originally-filed application at, for example, paragraphs 0031 and 0032, as well as by paragraph 0036, and therefore does not comprise "new matter."

Claim 87 is believed allowable over Lee I for at least the reason that Lee I does not disclose or suggest any improvement in conformality obtained utilizing the process disclosed therein. Lee I describes a process in which a hafnium-containing precursor having a ligand with high electronegativity is combined with an aluminum-containing precursor having a ligand with lower electronegativity; and in which the differences in electronegativity of the ligands drives a reaction that results in a mixture of hafnium and aluminum being deposited over a substrate. Lee I indicates that the interaction of the hafnium-containing precursor and aluminum-containing precursor causes a hafnium-aluminum material to be uniformly formed on a semiconductor substrate (see, for example,

paragraph 0045), with the description of the "uniform formation" being directed toward the homogenous composition of such material, rather than toward conformality of the material across a substrate. Nothing in Lee suggests that the utilization of the aluminum-containing precursor has improved conformality of the mixed composition of aluminum and hafnium relative to the conformality that would occur utilizing the hafnium-containing precursor alone. Further, nothing in Lee, or any of the other cited references, suggests that utilization of hafnium chloride with an aluminum-hydrocarbon material will lead to an improvement in the conformality of a layer formed from the hafnium-containing precursor relative to that which would occur in the absence of the aluminum-containing precursor. Accordingly, claim 87 is believed to recite subject matter which is not shown or suggested by the cited references, and therefore is believed to be allowable over such references.

It is also respectfully submitted that the claim 87 recited limitation of the TMA improving conformality of a hafnium-containing material relative to conformality that would occur in the absence of the TMA is not inherent in Lee I, or in any combination of Lee I with the other cited references. There is no teaching in any of the references that utilization of hafnium chloride with aluminum-hydrocarbon precursor would lead to improved conformality relative to utilization of hafnium chloride alone, and accordingly there is no reason to expect that something analogous to the claim 87 recited improvement in conformality would occur when utilizing the process recited in Lee I.

Applicant notes that the Examiner indicated in the previous action that the Grunwald reference (US Patent 6,007,875) shows that there would be a difference in electronegativity between an amide ligand and a hydrocarbon ligand, and thus the Examiner contended that

the Grunwald reference shows that it would be reasonable for a person of ordinary skill in the art to extend the teachings of Lee to applications of the type recited in claim 87 (previously claim 1) in which an aluminum-containing precursor with hydrocarbon ligand is combined with a hafnium-containing precursor with amide ligand.

Application respectfully submits that even if it were reasonable to extend the teachings of Lee toward a process of the type presently recited in claim 87 in which aluminum-hydrocarbon precursor is combined with hafnium-amide precursor, there still would be no suggestion within the cited references that such process would lead to an improvement in conformality of a hafnium-containing material deposited by the process relative to the conformality of a hafnium-containing material deposited in the absence of TMA. Further, the relative concentrations of TMA to TMEAH (or TDMAH) may affect whether a process actually improves conformality relative to a process lacking TMA, or does not lead to improvement due to the concentration of TMA being too small to significantly influence the conformality of the hafnium-containing precursor (see, for example, paragraph 0039 of the originally-filed application).

Nothing in the cited references suggests or discloses that there would be any improvement in conformality utilizing an aluminum-containing precursor in combination with the hafnium-containing precursor, and accordingly there is no teaching that the relative concentrations of aluminum-containing precursor and hafnium-containing precursor should be such that conformality is improved. For this additional reason, it is not inherent that processes of Lee I, either alone, or extended to include teachings from Grunwald, would

lead to the claim 87 recited process in which TMA improves conformality of a hafnium-containing material relative to conformality that would occur in the absence of TMA.

Claim 87 is believed allowable for the reasons discussed above, and applicant therefore requests formal allowance of such claim in the Examiner's next action.

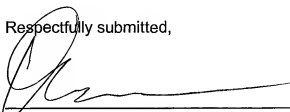
Claims 10-13 depend from claim 87, and are therefore believed allowable for at least the reasons for which claim 87 is believed allowable.

Referring next to claim 20, such claim, like claim 87, recites a process in which utilization of TMA improves conformality of chemisorbed hafnium-containing material relative to conformality that would occur in the absence of TMA. Claim 20 is therefore believed allowable for reasons similar to those discussed above regarding claim 87.

Claims 28, 31 and 33 depend from claim 20, and are therefore believed allowable for at least the reasons discussed above regarding claim 20.

Claims 10-15, 20, 28, 31, 33 and 87 are believed allowable for the reasons discussed above. Applicant therefore respectfully requests that the Examiner's next action be a Notice of Allowance formally allowing all of the such claims.

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Respectfully submitted,  
  
By: \_\_\_\_\_  
David G. Latwesen, Ph.D.  
Reg. No. 38,533